Big Picture Thinking

NASA Project Management Challenge 2008

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Purpose of this Presentation

- Describe the value of 'big picture thinking' and how this relates to a "mandate" for your project(s)
- Review some methods you can use to empower your big picture thinking
  - Processes
  - Tips & Techniques
- Illustrate the application of big picture thinking using a Constellation case study.

The Value of Big Picture Thinking

- Areas where big picture thinking has proven to be particularly valuable include:
  - Complex problems involving many stakeholders
  - Recurring problems
  - Issues where an action affects the environment
  - Problems with solutions that are not obvious

Ref. 6, Aronson

The Value of Big Picture Thinking (cont.)

- **Risk Reduction:** Big picture thinking helps to identify risks early in the life cycle
- **Project Success:** Big picture thinking can dramatically reduce a projects likelihood of becoming a statistic
  - Widespread failures common : Projects cancelled / over one year late / overruns in excess of 100%
  - Catastrophic Failures

Catastrophic Failures

- Columbia
- Hubble- When it was made, the glass for the mirror was carefully ground and polished to a near perfect surface. The problem was, it was ground into the wrong shape!
- Mars Observer – Could not establish contact once at Mars ($1 Billion)
- Mars Polar Lander - Spurious signals caused the trio of lander legs to deploy during descent making it think it had landed, although it was high above the Mars surface.

Genesis – lost 27 months worth of space data when it crashed because a sensor was designed backwards

Definition of 'Big Picture Thinking'

Tactical ?

Strategic ?

Outside the Box ?

Attention to Interface Details ?

Michael Griffin on Systems Engineering and Big Picture Thinking

- True systems engineering is about minimizing the unintended consequences of a design.
- Lead Systems Engineers are often buried in the details. Lead SEs must understand the big picture and delegate the details.
- Big picture thinking is more of an innate talent possessed by some, as opposed to an easily learned competency.

NASA PM Challenge 2006 Presentation Comments

Enablers

- NPR 7123.1 (Ref. 4, NASA Systems Engineering Processes and Requirements)
- NASA Systems Engineering Handbook. (Ref. 5)

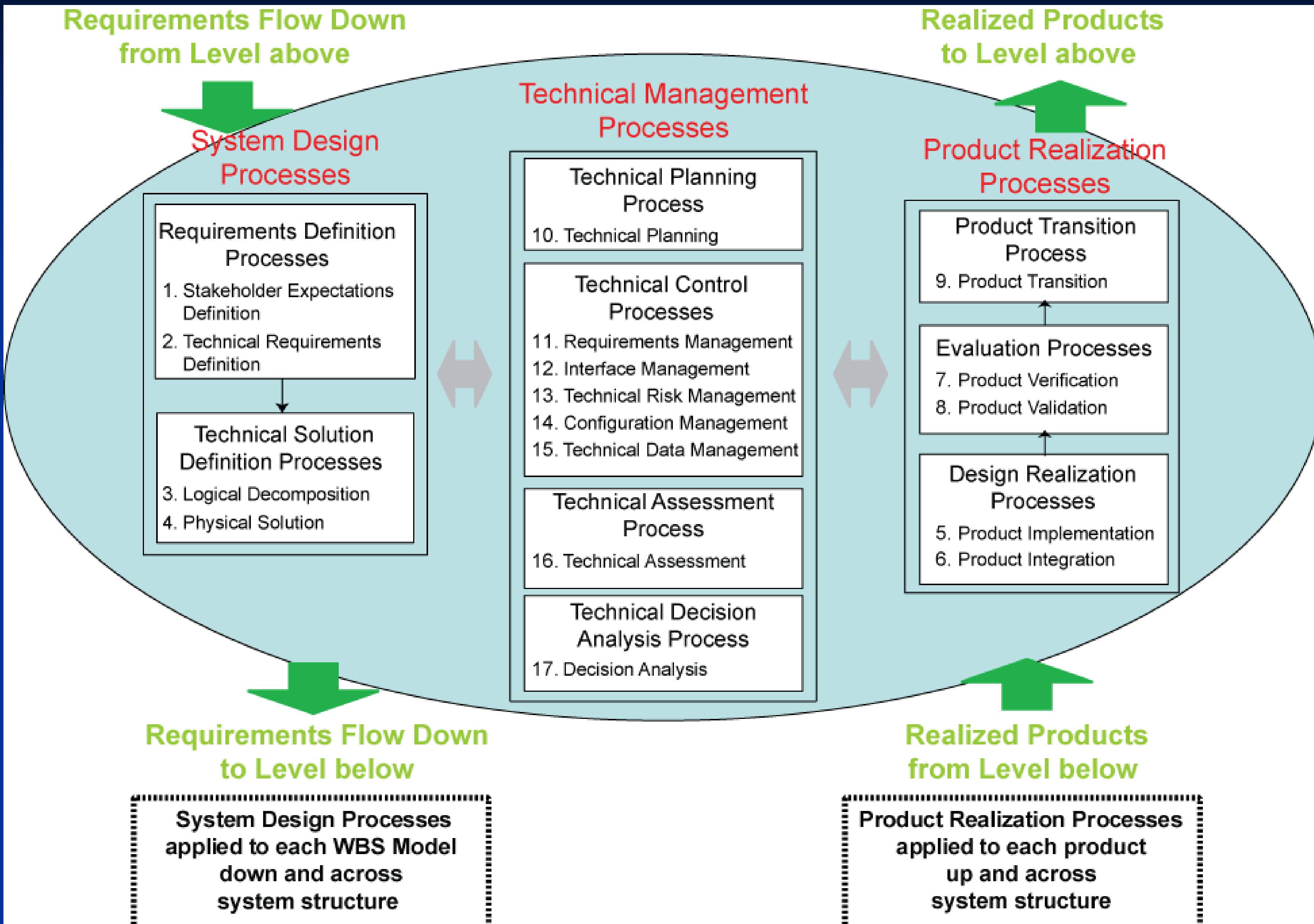
The Mandate for you and your project:

NPR 7123.1 (Ref. 4, NASA Systems Engineering Processes and Requirements)

- Systems engineering at NASA requires the application of a systematic, disciplined engineering approach that is quantifiable, recursive, iterative, and repeatable for the development, operation, maintenance, and disposal of systems; integrated into a whole **throughout the life cycle** of a project or program. The emphasis of systems engineering is on safely achieving **stakeholder, functional, physical, and operational performance requirements in the intended use environments** over the system's planned life within cost and schedule constraints.

http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7123_001A_&page_name=main

NPR 7123.1 A SE Engine (Ref. 4)



NPR 7123.1 Checklists (Ref. 4)

Two checklists (entrance criteria and success criteria) provided for major milestone reviews:

Mission Concept
Systems Requirements
Mission Definition
System Definition
Preliminary Design
Critical Design

Test Readiness
System Acceptance
Flight Readiness
Operational Readiness
Decommissioning

NPR 7123.1A, Appendix G "Checklists"

SEAS Department System Requirements Review (SRR) Checklist

Instructions for using this form are on the last page.

Project	
Project Manager (type name and sign)	**Section Manager (type name and sign)**

Item	Clarification/Example Products	Rating	Products	Location	Comments
Are project definition/predecessor review inputs adequate?					
Does the approved project plan clearly identify each deliverable and each review?	Project plan				
Does the project overview describe the project, including project objectives, assumptions, and constraints?	Project overview, assumptions, guidelines, and constraints. Project statement: "We will deliver an XXX on DATE for $XX."				
Is the upper-level WBS complete?	Project WBS and WBS dictionary				
Is the risk management approach defined? Are risks being actively managed?	Tools and training in place; initial risks in database				
Is the Configuration Management Plan (CMP) complete and are CM requirements defined?	Project CMP, including identification of specific configuration controlled items and when each item goes under configuration control.				
Is the Software Development Plan (SDP) complete?	Project SDP including computer language, coding standards, development platform, and required peer reviews, etc., are defined.				
Are review meeting preparations complete?					
Are the logistics defined; i.e., the date, place, time, and documents to RID?	Invitation memo				

Enablers (continued)

- NASA Systems Engineering Handbook. (Ref. 5)
  http://ntrs.nasa.gov/search.jsp?R=174432&id=2&qs=Ntt%3DNASA%252BSystems%252BEnginering%252BHandbook%26Ntk%3DKeywords%26Ntx%3DDmode%2520matchall%26N%3D0%26Ns%3DHarvestDate%257c1
  - Well defined concept of operations (Sect. 4.1.2.1)
  - Well defined interface requirements (Appendix F)
  - Continuous Risk Management (Section 6.4.2)

Yes, but ….

I can't because….

- **"I'm too busy"** working my contractually-defined effort to worry about someone else's work.
- **"I don't know how"** - Lack of familiarity with how to go about big picture thinking.
- **"My boss won't let me"** - Project/organization does not value/encourage big picture thinking.
- **"I don't want to"** - NIH (not invented here) syndrome. (Ref. 3, "Launching a Leadership Revolution" page 46)

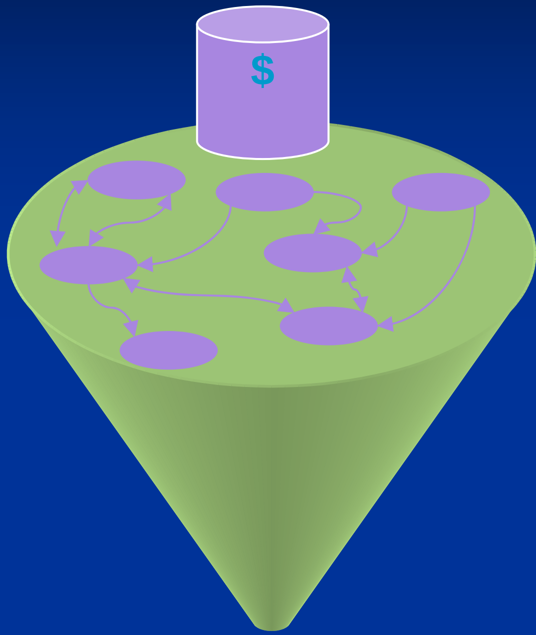
How Much Big Picture Thinking is Too Much?

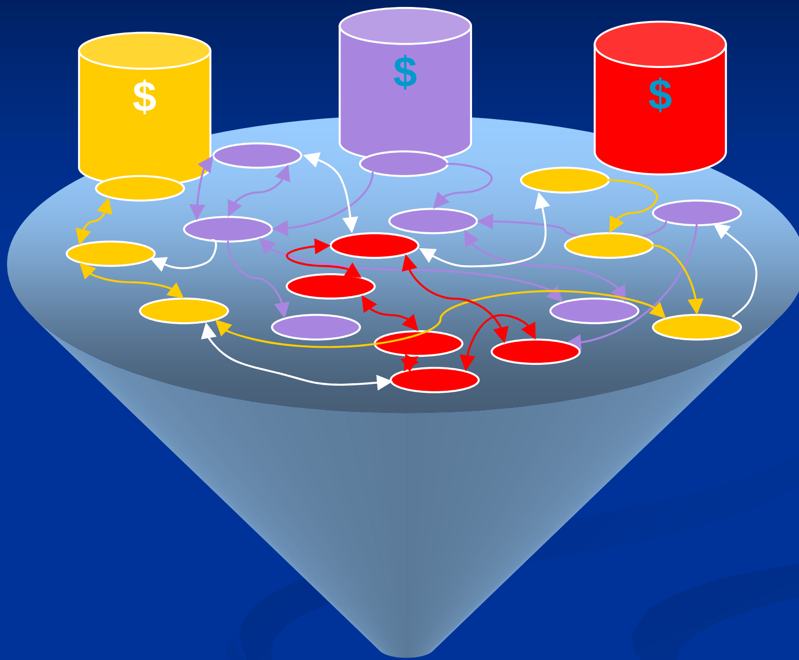
- Some will argue ANY thinking outside of the tasks and deliverables called out in the project contractual requirements is too much.
  - The real key is looking to see how the big picture affects your project decisions, risks, and opportunities. When this kind of 'Return on Investment' fades, that is probably "enough."
  - Big picture thinking should dare to look beyond your immediate end user expectations.
    - Downstream iterations of your project
    - Reuse Potential
    - Planned obsolescence? – space communication systems as an example.

More Roadblocks

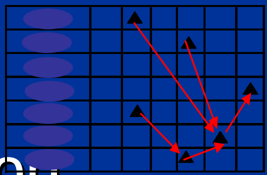
- Key elements of the big picture are either not ready or not willing to collaborate on big picture issues and topics.
- Complex program structures can make big picture thinking more challenging

The Big Picture –The Management Challenge (Ref. 1, Dahlman)

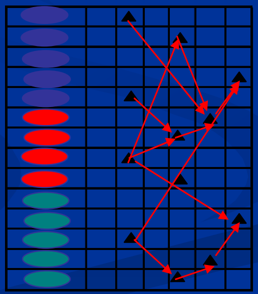




Within
Single
Organization



Interdependencies
Across
Multiple
Organizations



Political and Cost Considerations Impact on Technical Issues

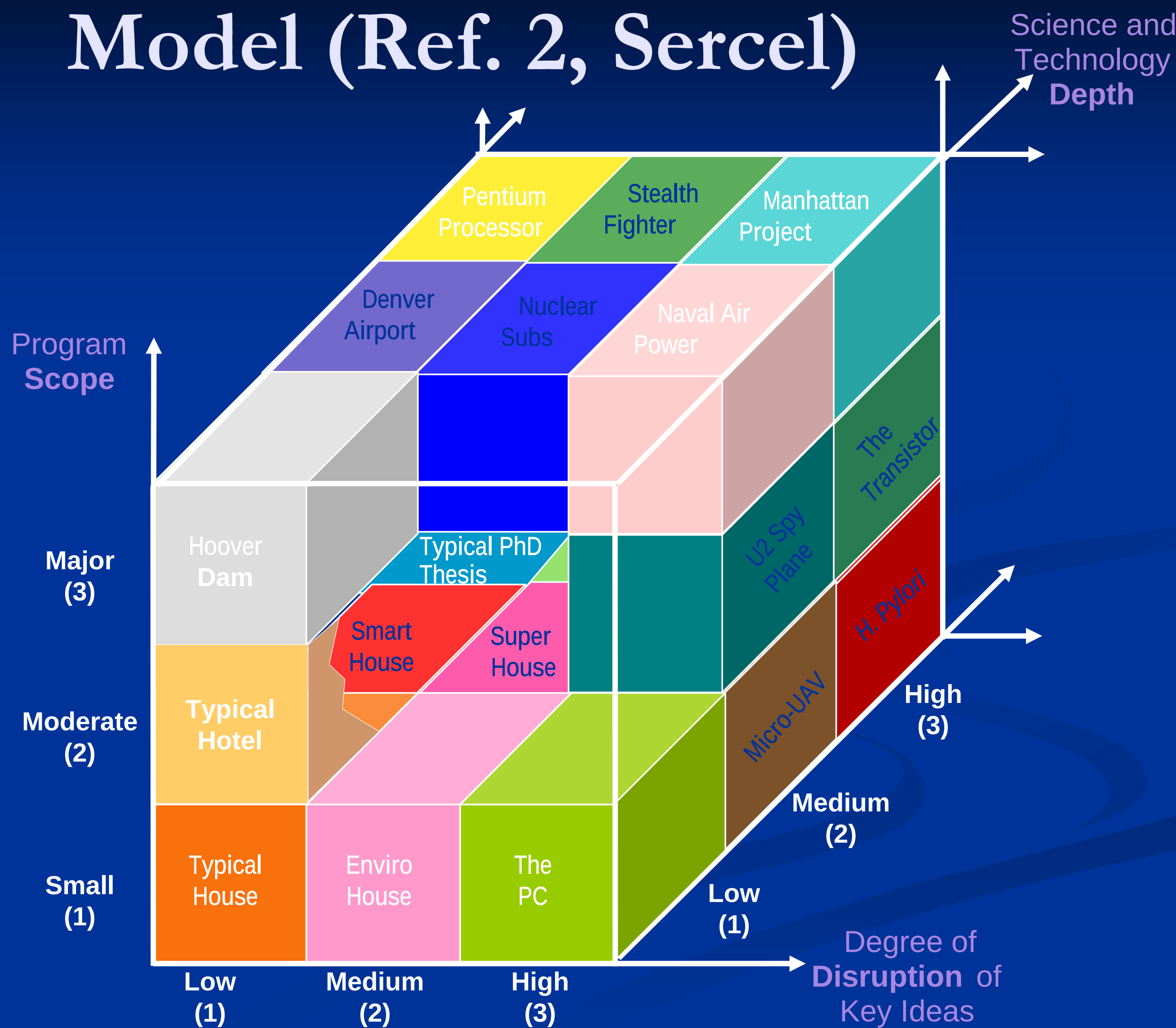
Tips for Effective Big Picture Thinking

- Think like your end user
  - Ensure you have an operational concept that shows how the **end users** will operate your system to support their needs.
- Context is key
  - The ability look at the project from various stakeholder views is essential.

Big Picture Context

- Dr. Joel Sercel, Technical Director of Systems Engineering at the Caltech Industrial Relations Center, encourages each enterprise to understand where projects in their portfolios fall, with respect to the D2S criteria (aka, Depth, Disruption and Scale). We must realize that a one-size-fits-all development process may not make sense. (Ref. 2)

Archetypical Programs in D2S Portfolio Model (Ref. 2, Sercel)



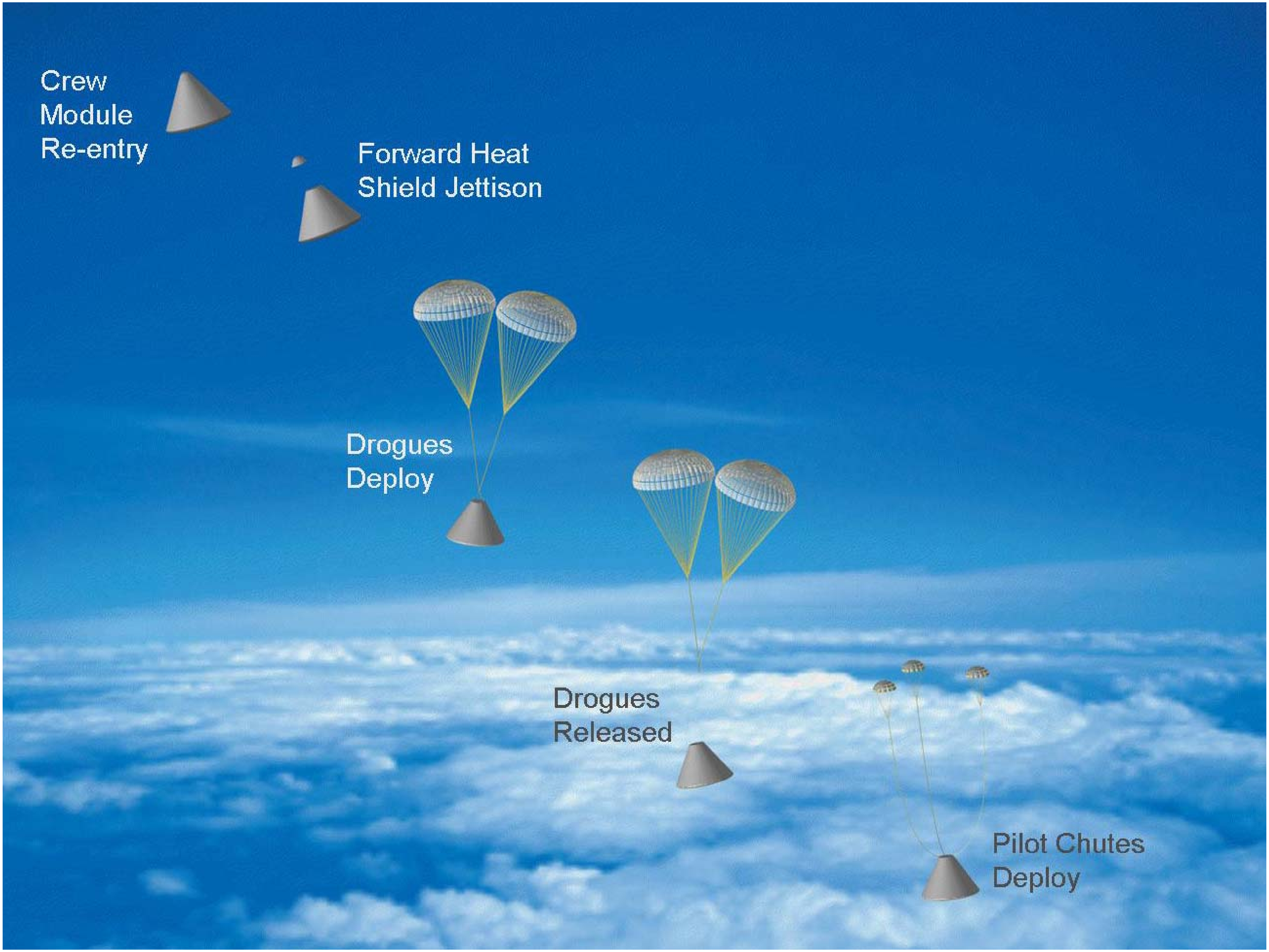
Big Picture Context (cont.)

- The Department of Defense is in the final stages of releasing a "System of Systems" Systems Engineering Handbook
- The handbook will emphasize tailoring systems engineering methodology to address big picture related challenges.

Big Picture Context (Ref. 1, Dahlman)

Constellation Case Study

- Crew Exploration Vehicle (CEV) Parachute Assembly System
- Government Furnished Equipment (GFE)

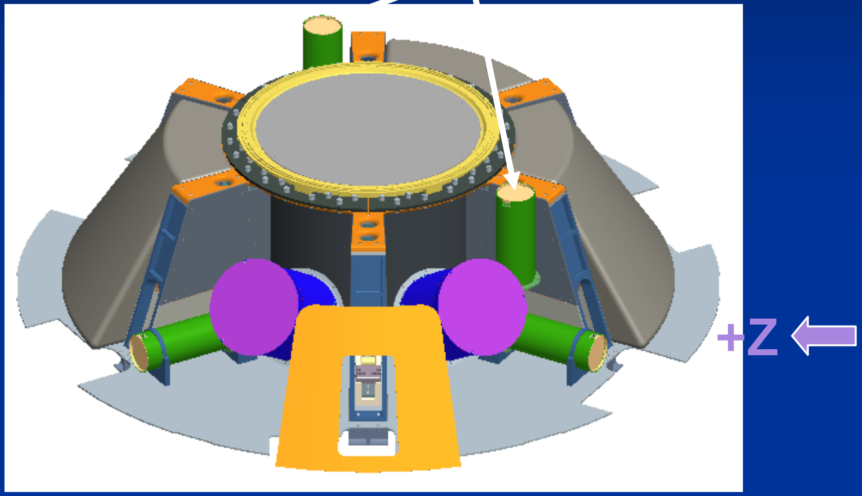

Crew Module Re-entry
Forward Heat Shield Jettison
Drogues Deploy
Drogues Released
Pilot Chutes Deploy

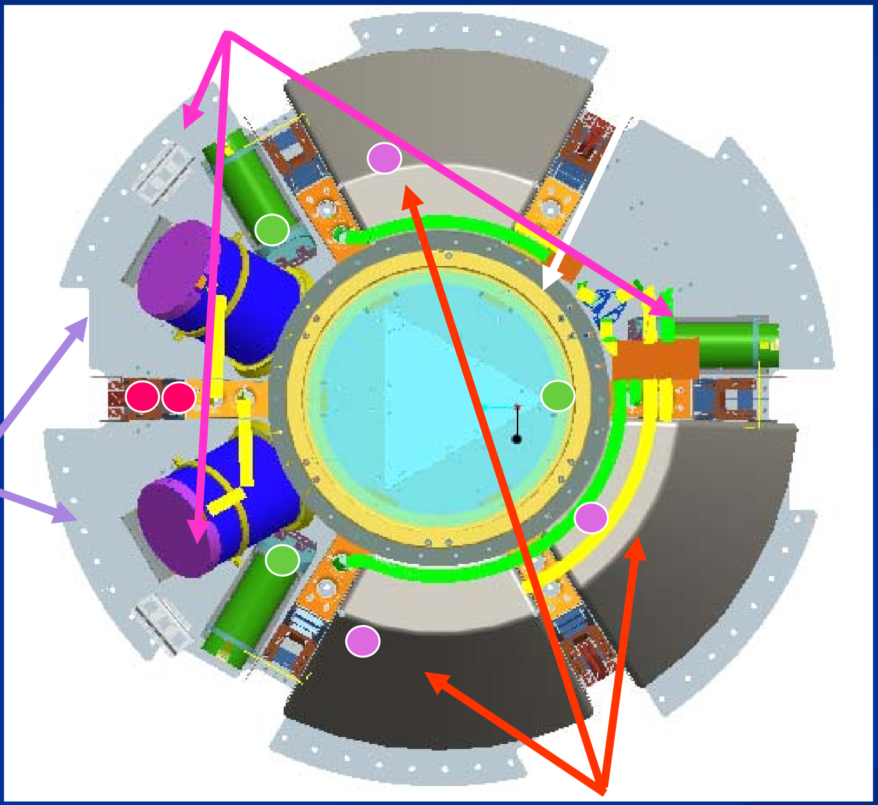
Forward Bay Compartment Layout

FBC Jettison Mortars

Three Pilot Mortars
~120º separation

One Confluence Fitting





Two Drogue Mortars
Parallel Deploy

Three Main Parachutes

Attach Points
- Drogue
- Pilot (to Main Deployment Bag)
- Main Harness

Multi-discipline Risk Identified

Serious risk identified during early simulations and flight tests. "Limit Cycle" oscillation under drogue parachutes, which could result in an unsafe crew module attitude during descent.

Designated as a big-picture risk, since timing of parachute deployment commands from Guidance, Navigation, and Control (GN&C) and parachute physical deployment are both key players in this phenomenon.

Risk Abatement Options

- Isolate instability "root cause"
  - offset drogue chute attachment points
  - Unfavorable rotational rate at drogue cut-away
- Minimize root cause effects
  - Special bridle (confluence fitting) centralize parachute vehicle load interactions
  - "Smart" Drogue release (GNC monitors Crew Module attitude & rates & releases CM at optimum time)
- Rethink overall Parachute Architecture

Big Picture View

End User (big picture) view revealed:

Simpler

More effective

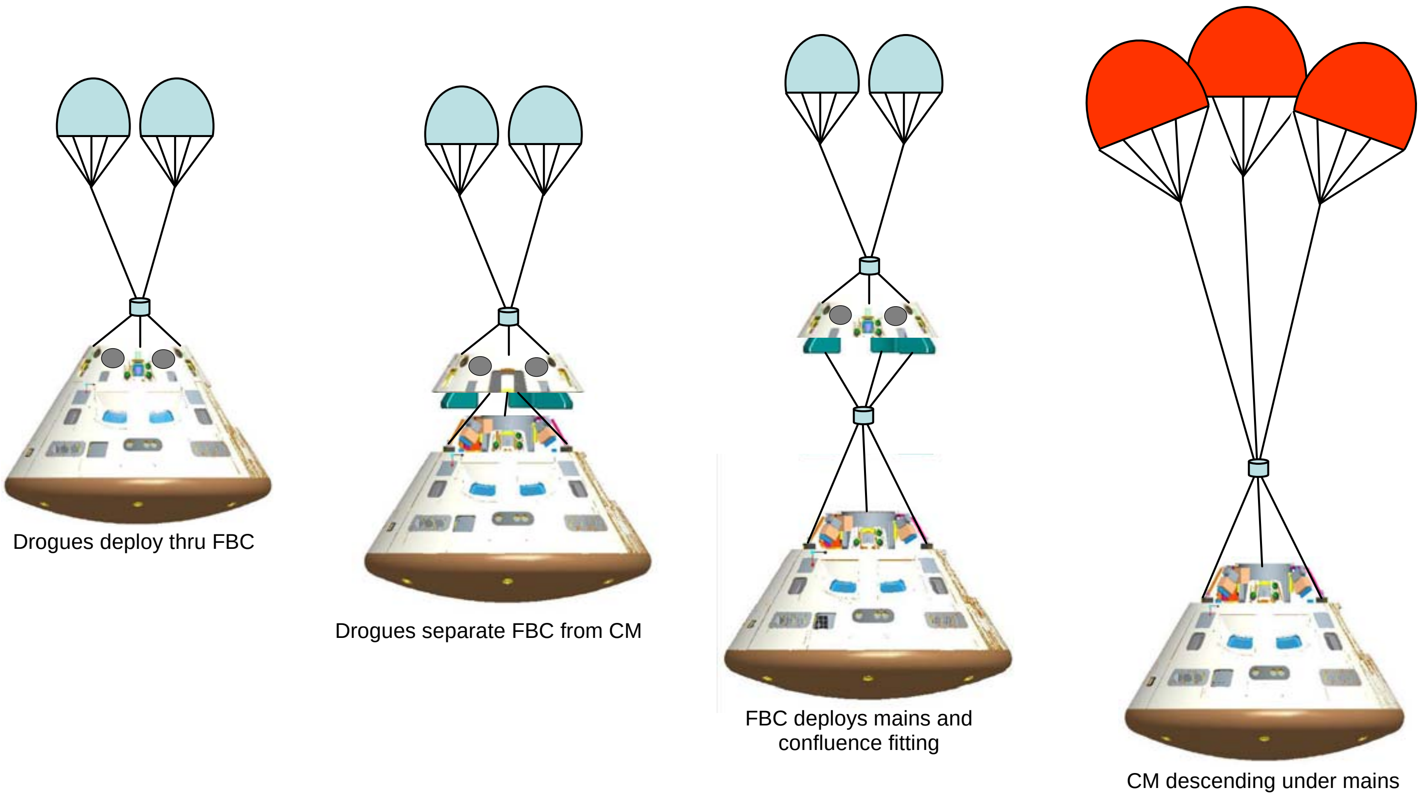
Lower cost

Lighter weight

Safer

Alternative

Big Picture Solution



Big Picture Solution

- The Forward Bay Cover (FBC) separation chutes to be used as a dual purpose parachute – both to slow the vehicle (in lieu of similar CPAS drogue parachutes) AND to physically move the separated FBC away from the descending vehicle.
- In lieu of separate mortars to deploy pilot parachute (which would then deploy main parachutes), the departing FBC is simply used to deploy the main parachutes.

Big Picture Thinking Return on Investment

- Risk 'probability of occurrence' dramatically reduced
- Reduced number of parachute-related critical events by almost 50%
- Overall safety increased by an order of magnitude
- Approximately 50 pounds lighter
- Fewer parachutes and fewer mortars (cheaper)

Parting Words

- Reach Higher!
  - Welcome interdisciplinary **stakeholder** views
  - Think beyond project current **life-cycle** phase
  - Assess the big picture from the end user (**validation**) view
  - Always ask "What could go wrong?"
  - When confronted with big picture dilemmas, realize that <u>you</u> are your project's technical conscience.
  - Share success stories

References

1. Department of Defense System of Systems Challenges, JSC Systems Engineering Seminar presentation. Dr. Judith Dahlman. August 2007
2. Emerging Technical Methods of Intelligence – Critical Disruptors for the 21st Century, IEEE Special Presentation. Dr. Joel Sercel. March 2008
3. Launching a Leadership Revolution. Chris Brady and Orrin Woodward
4. NPR 7123.1A, NASA Systems Engineering Processes and Requirements. March 2007
5. SP-2007-6105, NASA Systems Engineering Handbook. Rev. 1. December 2007
6. Using Systems Thinking to Increase the Benefits of Innovation Efforts. Daniel Aronson. <u>Innovative Leader</u> newsletter. Volume 6, No. 2

Questions?

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